# The SNPP and JPSS Satellite Reprocessing

## Status Updates, How to Acquire, Application Examples

C.-Z., Zou, L. Zhou, L. Lin, X. Hao, B. Zhang, K. Ahmad, N. Sun, H. Yang; Y. Chen, T. Beck, B. Yan, and F. Iturbide-Sanchez

NOAA/NESDIS/Center for Satellite Applications and Research (STAR)
NOAA/NESDIS/Joint Polar Satellite System (JPSS)

**National Environmental Satellite, Data, and Information Service**

March 17, 2023

# Reprocessing and Benefits

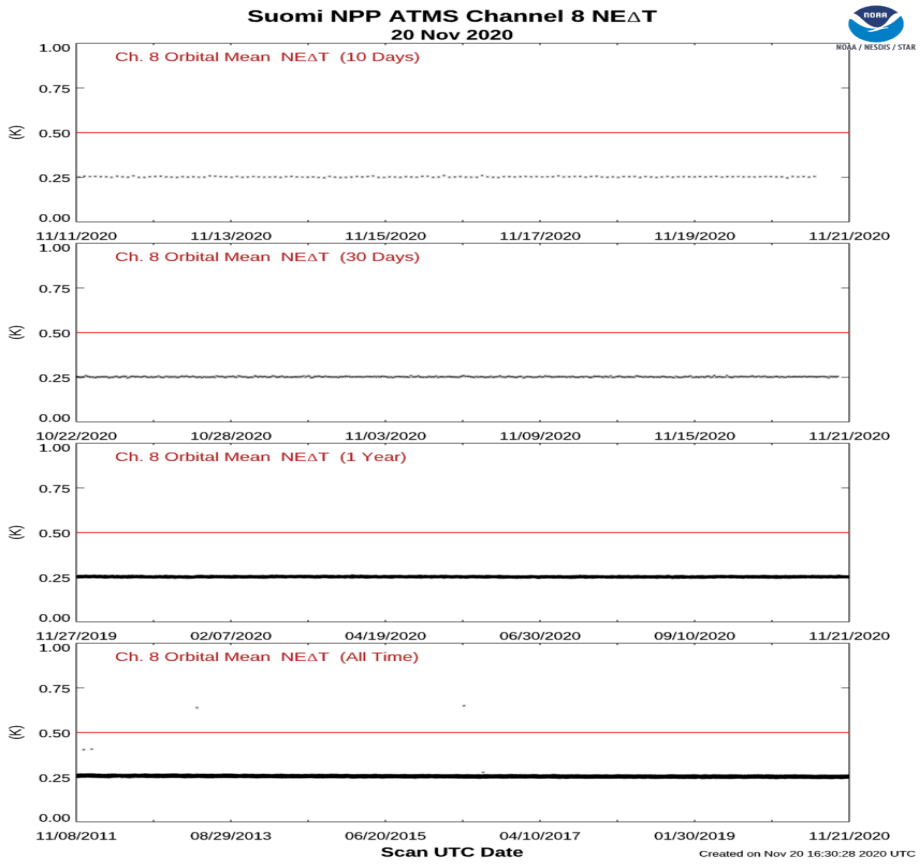
- Single satellite operational calibration algorithms update and improve over time
- Use most recently updated, unified calibration algorithms to generate consistent SDRs for each JPSS/SNPP instrument through their life cycle - Reprocessing efforts are tied closely to the cal val activities: the products are ready for reprocessing when reach validated maturity
- Calibration accuracy for SDRs achieves those from the latest operational calibration algorithms
- JPSS/SNPP V1 and V2 Reprocessing completed successfully, see next slides
- Allow stability assessment after removal of bias jumps due to operational calibration changes– quantify SDR quality in the time dimension
- Consistent satellite retrievals allows:
  - Improved environmental data record (EDR) products
  - Building blocks for climate data record (CDR) development
  - Improve climate reanalysis as input datasets
  - Climate trends analyses

# Status of SNPP SDR Reprocessing

| Sensor | Data Type (name) | Period | Notes | Volume (Tb) | Transition to CLASS Status |
|---|---|---|---|---|---|
| ATMS | TDR (TATMS) | 2011-11-08 to 2019-10-15 | V2 | 0.406 | Completed on Dec. 19, 2021 |
| | SDR (SATMS) | 2011-11-08 to 2019-10-15 | V2 | 0.431 | |
| | GEO (GATMO) | 2011-11-08 to 2019-10-15 | V2 | 0.420 | |
| ATMS | TDR (TATMS) | 2011-11-08 to 2017-03-08 | V1 | 0.273 | Completed on Dec. 30, 2021 |
| | SDR (SATMS) | 2011-11-08 to 2017-03-08 | V1 | 0.289 | |
| | GEO (GATMO) | 2011-11-08 to 2017-03-08 | V1 | 0.283 | |
| CrIS | GCRSO | 2012-02-20 to 2020-01-29 | V2 | 0.369 | Completed on Feb. 25, 2022 |
| | SCRIS | 2012-02-20 to 2020-01-29 | V2 | 67.994 | |
| | SCRIF | 2014-12-04 to 2020-01-29 | V2 | 74.455 | |
| OMPS | TC (SOMTC, GOTCO) | 2012-01-30 to 2018-09-30 | V1 | 1.139 | Completed on Mar. 9, 2022 |
| | NP (SOMPS, GONPO) | 2012-01-25 to 2017-03-08 | V1 | 0.097 | |
| OMPS | NP (SOMPS, GONPO) | 2012-01-25 to 2021-06-30 | V2 | 0.191 | Completed on Mar. 9, 2022 |
| | TC (SOMTC, GOTCO) | 2012-01-30 to 2021-06-30 | V2 | 1.649 | |
| VIIRS | VIIRS ALL SDR | 2012-01-02 to 2020-04-30 | V2 | 1615 | to be completed on October 2023 |
| **Total** | --- | --- | --- | **1764.65** | |

# Assessment of Consistency and Stability of Reprocessed SDRs

- Compare with operational SDRs
- Compare with similar channel observations from other instruments onboard other satellites
- Check ICVS for instruments performance (figure on the right: Absolute stable NEDT performance support the high radiometric stability conclusion )

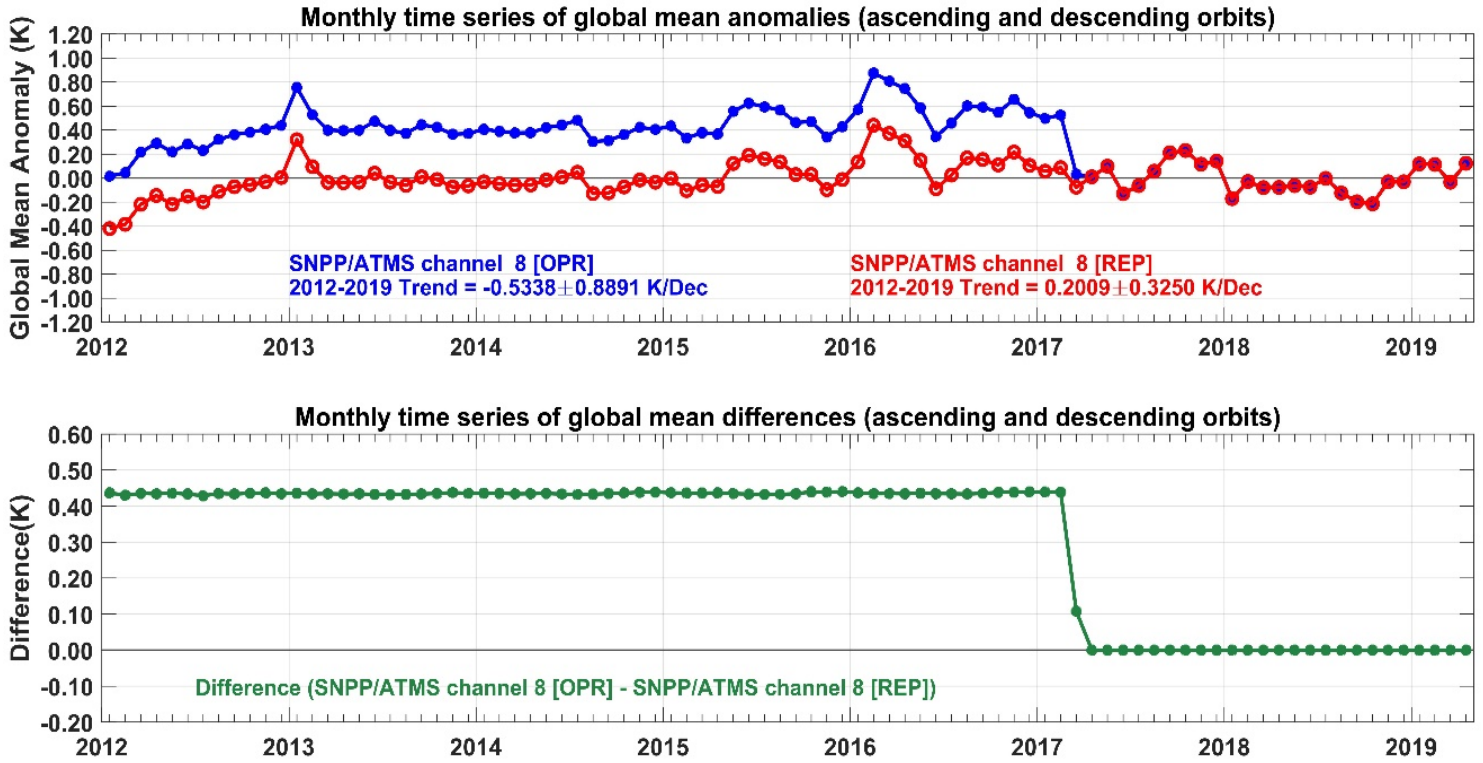


# Compare Operational and Reprocessed SDRs—SNPP/ATMS

*Changes in operational calibration cause bias jumps

*The bias jump between the operational calibrated and reprocessed data found in March 2017 was caused by the calibration update for the operational calibration on 8 March 2017

*After that date, the two datasets are identical since they use the same calibration algorithm




Monthly global mean anomaly $T_b$ time series for ATMS channel 8 from operational calibrated (blue, top) and reprocessed (red, top) sensor data records and their differences (green, bottom). The global means are calculated using limb-adjusted scan positions from 29 to 68 for both operational calibrated and reprocessed datasets. The limb-adjustment and data processing details can be found in Zou et al. (2018).

# Stability Assessment of Reprocessed SDR—SNPP/ATMS

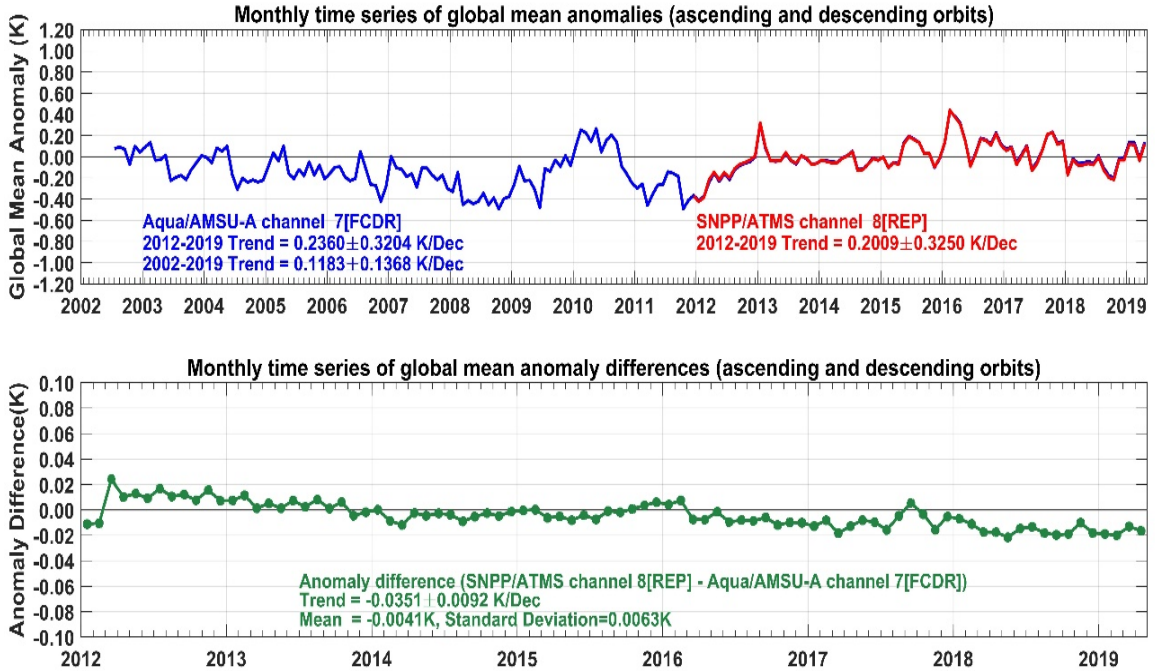
- **Reprocessed SNPP/ATMS** are compared with **Aqua/AMSU-A** for their companion channels

- Diurnal sampling difference is absent
  - they are naturally removed by satellites with stable orbits with the same overpass time

- Time series from different satellites match with each other nearly perfectly without applying any diurnal drift corrections or time-dependent inter-calibration

- Calibration drifts could be estimated quite accurately

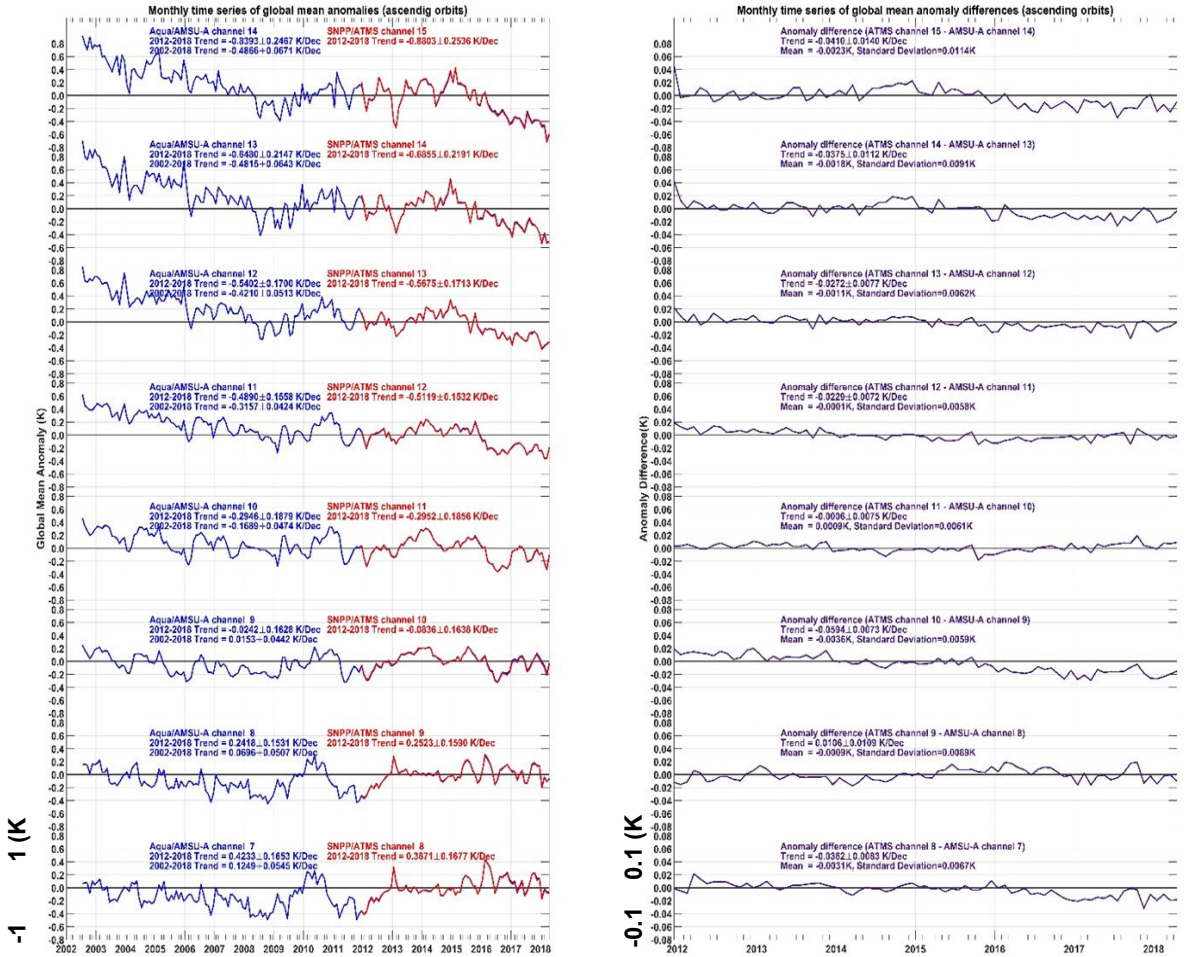
- Small trend differences suggest high radiometric stability for either instrument




Monthly global mean $T_b$ anomaly time series for AMSU-A channel 7 onboard Aqua (blue, top) versus ATMS channel 8 onboard SNPP (red, top) and their difference time series (green, bottom). The AMSU-A and ATMS data are from June 2002 and December 2011 to December 2018, respectively. The AMSU-A anomaly time series are overlaid by ATMS during their overlapping period, with their differences shown as nearly a constant zero line in the same temperature scale. Amplified scale of temperature is used in the bottom panel to show detailed features in the anomaly difference time series. Both ATMS and AMSU-A data are from limb-adjusted scan positions of 29-68 and averaged over ascending and descending orbits. Uncertainties in trends represent 95% confidence intervals with autocorrelation adjustments.

# High Radiometric Stability in Aqua, MetOp-A, and SNPP Microwave Sounder Observations

- Time series from Aqua/AMSU-A and SNPP/ATMS match with each other extremely well without applying any time-dependent inter-calibration
- Calibration drifts can be estimated quite accurately
- Small trend differences suggest highly stable observations with either instruments
- Radiometric stability achieved 0.04K/Decade for most channels for SNPP/ATMS, Aqua/AMSU-A, and MetOp-A/AMSU-A (Zou et al. 2018)




Left: Anomaly time series of Aqua/AMSU-A (blue) and SNPP/ATMS (red); Observation; Right: Their difference time series (plot from Zou et al. 2018)

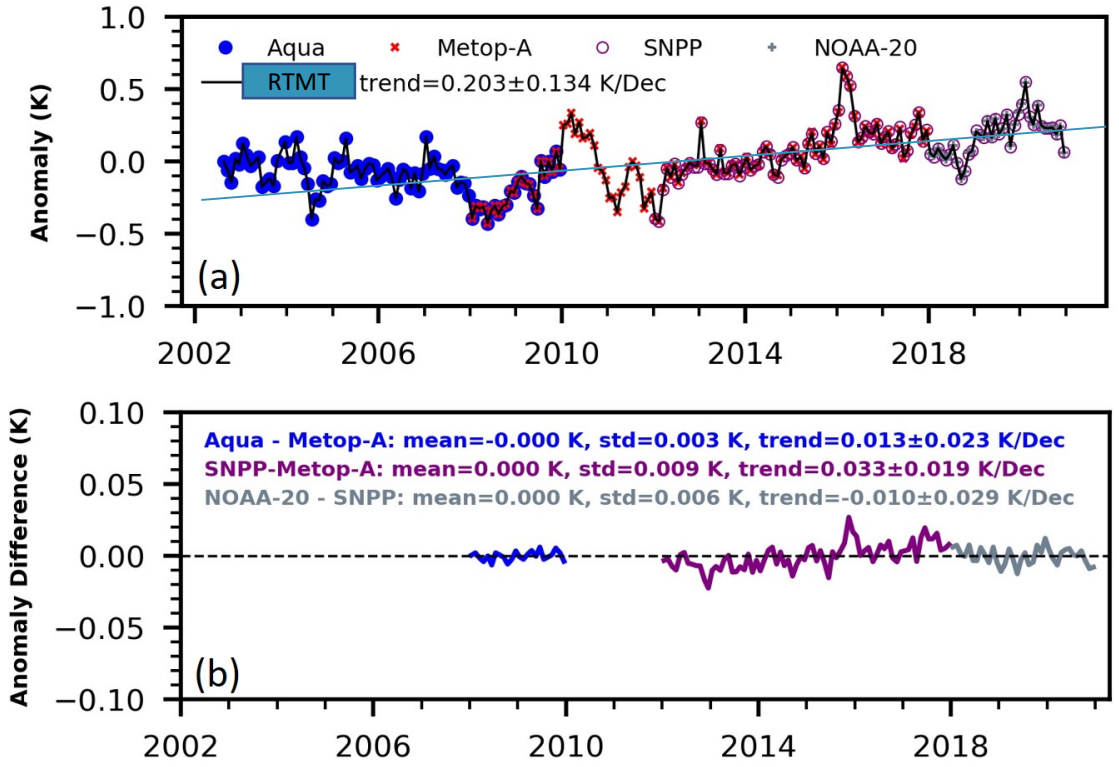
# Reference Temperatures in the Mid-Troposphere (RTMT) Time Series

- Maximum relative drift between satellite pairs: 0.033 K/Decade

- RTMT is an average of available satellite observations which gives a trend of 0.203 K/Decade during 2002-2020

- Small sampling theory gives a trend uncertainty= $\pm \frac{\Delta}{2\sqrt{N}}$ =0.01K/Decade; here $\Delta$=0.033 K/Decade, N=2 is the overlapping satellite number

- Accuracy in trend detection exceeds the required 0.02K/Decade given in GCOS (2016)




(a) Monthly global mean temperatures in the mid-troposphere (TMT) anomaly time series from Aqua, MetOp-A, SNPP, and NOAA-20 and the reference TMT (RTMT) time series merged from these satellites; (b) inter-satellite difference time series before the merging. Anomalies are relative to a monthly climatology of RTMT for the MetOp-A period from January 2008 to December 2017. Uncertainties in trend calculations represent 95% confidence intervals with autocorrelation adjustments (Plots are from Zou et al. 2021).

# User Access to the Reprocessed Data from CLASS

- Two options to get the reprocessed SNPP SDR data from NCEI/CLASS

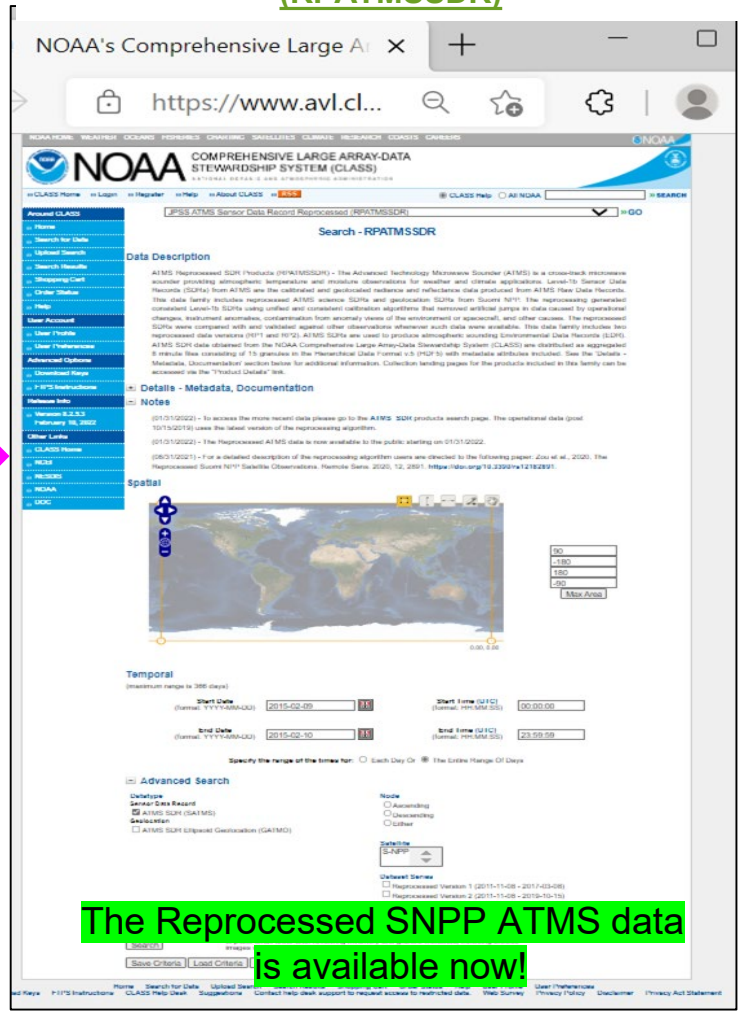
**A. Tar file FTP download before order interface is available**

| | |
|---|---|
| **Data Access Services** | • CLASS FTP |
| **Data Access Locations** | CLASS FTP:<br>•ftp://ftp-jpss.avl.class.noaa.gov/STAR/ |
| **Data Access Configurations** | • Data directory structure:<br>• .../<YYYYMMDD>/<Data_Family>/<Data_Type>/<Sat>/<***file_name***><br>• Aggregate native HDF files into ~daily tar files by data type<br>• Frequency options:<br>• "**Append with Updates**"<br>• Version configurations:<br>• "**New**" |
| **Additional Information** | Data available for past 85 days. |

**B. Archive Tape Search and Order (CLASS search and order interface)— Next page**

# CLASS Search and Order Data Interface


JPSS ATMS Sensor Data Record Reprocessed (RPATMSSDR)



# Documentation

## Selected Publications


- Zou, C.-Z., Zhou, L., Lin, L., Sun, N., Chen, Y., Flynn, L. E., Zhang, B., Cao, C., Iturbide-Sanchez, F., Beck, T., Yan, B., Kalluri, S., Bai, Y., Blonski, S., Choi, T., Divakarla, M., Gu, Y., Hao, X., Li, W., Liang, D., Niu, J., Shao, X., Strow, L., Tobin, D. C., Tremblay, D., Uprety, S., Wang, W., Xu, H., Yang, H., & Goldberg, M. D. (2020). The Reprocessed Suomi NPP Satellite Observations. Remote Sensing, 12(18). [10.3390/rs12182891]
- Chen, Y., Iturbide-Sanchez, F., Tremblay, D., Tobin, D., Strow, L., Wang, L., Mooney, D. L., Johnson, D., Predina, J., Suwinski, L., Revercomb, H. E., Sun, N., Zhang, B., Cao, C. Y., Kalluri, S., & Zhou, L. H. (2021). Reprocessing of Suomi NPP CrIS Sensor Data Records to Improve the Radiometric and Spectral Long-Term Accuracy and Stability. IEEE Transactions on Geoscience and Remote Sensing, 60, 1-14. [10.1109/TGRS.2021.3060639]
- Uprety, S., Cao, C., Gu, Y., Shao, X., Blonski, S., & Zhang, B. (2019). Calibration Improvements in S-NPP VIIRS DNB Sensor Data Record Using Version 2 Reprocessing. IEEE Transactions on Geoscience and Remote Sensing, 57(12), 9602-9611. [10.1109/TGRS.2019.2927942]
- Cao C, Zhang B, Shao X, Wang W, Uprety S, Choi T, Blonski S, Gu Y, Bai Y, Lin L, Kalluri S.(2021). Mission-Long Recalibrated Science Quality Suomi NPP VIIRS Radiometric Dataset Using Advanced Algorithms for Time Series Studies. Remote Sensing. 13(6):1075.
- Yan, B., C. Pan, T. Beck, X. Jin L. Wang, D. Liang, L. Flynn, J. Chen, J. Huang, S. Buckner, C.-Z. Zou, N. Sun, L. Lin, A. Yong, L. Zou, and W. Hao, 2022: Life-Time Quality-Consistent Suomi NPP OMPS Nadir Sensor Data Records: Calibration Improvements and Performance Assessment of Reprocessed Data Sets. Remote Sens., 14(13), 3125; https://doi.org/10.3390/rs14133125.

# Backup